



Materials Engineering Branch

TIP*



No. 036 Cadmium Plating on Spacecraft Hardware

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For many years cadmium has been considered a non-qualified material for space applications. Yet, a number of cadmium-plated components have been and are being used in the form of electrical connectors, bolts, nuts and other high-strength steel fittings and attachment hardware. The main reason why cadmium is considered unsuitable is that it is volatile in a vacuum environment and it evaporates and recondenses on optics to degrade them or on electrical components to cause conductive paths and resulting shorting.

Many weight loss tests, using an Ainsworth vacuum microbalance, have been conducted to illustrate that evaporation of cadmium plating in hard vacuum cannot be detected below $\approx 100^{\circ}\text{C}$. Allowing for the possibility that a more sensitive detection system, e.g., a mass spectrometer, might produce slightly different results and reducing the cadmium evaporation threshold temperature in vacuum from 100°C to 75°C to assure a comfortable margin of safety, there should be numerous space flight applications for which cadmium plated components would be acceptable. As most spacecraft do not experience temperatures even approaching this value, there is essentially no danger of detectable cadmium plating evaporation.

However, cadmium plating when applied by an electro-deposition technique may cause some concern because it has, in rare cases, resulted in the growth of whiskers. Other metallic platings (electro-deposited), such as tin and zinc, have grown whiskers that have caused shorting in low-current devices in telephonic applications. The growth of such whiskers is attributed to the residual stresses in thin platings that cause atom movement via screw dislocations. Of the three metal platings, cadmium has the lowest tendency for whisker growth. Although the authors have noted whiskers growing from a zinc plated radio chassis and from a tin-plated multi-pin electrical connector, none have been noted on cadmium-plated hardware, even after several years' storage. Therefore, the possibility of the whisker problem on cadmium plated electrical connectors is very remote.

Still, protection against that possibility could be afforded by the use of molded rubber inserts that fill the void areas of mated connectors and, thereby, prevent any whiskers from making electrical contact.

Even though the use of cadmium-plated connectors and other cadmium-plated hardware can reduce the cost and lead-time of procurement in many cases, do not overlook the fact that cadmium is still considered to be unacceptable for general space flight use. Any proposed use of cadmium-plated hardware will be evaluated on the basis of the specific application coupled with the availability of other suitable materials.